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How to cite:

Moore, Adam; Goulding, James; Brown, Elizabeth and Swan, Jerry (2009). AnswerTree – a hyperplace-based game for collaborative mobile learning. In: Proceedings of the mLearn 2009 Conference, 26-30 Oct 2009, Orlando, Florida, USA.

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AnswerTree – a Hyperplace-based Game for Collaborative Mobile Learning

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ABSTRACT

In this paper we present *AnswerTree*, a collaborative mobile location-based educational game designed to teach 8-12 year olds about trees and wildlife within the University of Nottingham campus. The activity is designed around collecting virtual cards (similar in nature to the popular Top Trumps™ games) containing graphics and information about notable trees. Each player begins by collecting one card from a game location, but then he or she can only collect further cards by answering questions – whose solutions are obtainable through sharing knowledge with other cardholders. This ostensibly allows each player to become a subject expert at the start of the game, encouraging collaborative interaction for the game to be successfully completed. In this initial paper we will outline the structure and background of this location based game. AnswerTree has been authored within the Hyperplace framework, and is a first implementation of a wider process to develop a flexible, multi-purpose platform for both individual and group location-based mobile learning.

Author Keywords

Collaborative learning, mobile learning, jigsaw learning, trees, location-based services.

INTRODUCTION

Mobile technologies that are aware of their location have become increasingly ubiquitous over the last few years (Milanesi et al., 2009). It has therefore now become both feasible and logistically straightforward to implement learning approaches that harness both an individual's location and other contextual cues, with content being delivered directly to mainstream mobile devices without the need for any specialist hardware. In this paper we present *AnswerTree*, a location-based educational game authored within the recently developed *Hyperplace* platform (Goulding and Swan, in preparation) that investigates the effectiveness of collaborative learning within a context-aware mobile system.

The AnswerTree case study explores how we can use contextual (in this case, location-based) data to support collaborative mobile learning, with an additional focus on whether this can be successfully supported within the Hyperplace framework. Whilst learning is often viewed as an individual pursuit, with a student's head stereotypically buried in a book (or possibly next to a screen), learning is frequently – and perhaps predominantly – a social activity. However, models of learning in a social context vary enormously. One model that has served as particular motivation for the development of AnswerTree is that of Aronson's *jigsaw learning* (Aronson & Patnoe, 1996; Aronson et al., 1975).

In jigsaw learning a class is divided into groups, with each group being divided into "subject experts". Individual experts from each group then join together to collaboratively research the topic they have been designated, before reconvening with their initial groups. Each expert then educates the rest of the group on their particular subject. It has been shown that collaborative learning of this manner can be mediated through online experiences (Clear & Kassabova, 2005) – and increasingly so with the adoption of Web 2.0 practices (O'Reilly, 2005). However, with AnswerTree we extend this investigation into mobile, location-based settings, building upon previous projects that have explored user interactions with mobile devices in outdoor environments (McCarthy & Meidel, 1999; Pascoe et al., 1998; Rieger & Gay, 1997).

As the devices available to potential learners have grown in sophistication, both in terms of their computational/presentational abilities (e.g. CPU, screen size, colour depth and resolution) and their awareness of their surrounding contexts (e.g. GPS, inertial sensors and compasses), the flexibility and sophistication of the learning experience that can be delivered has also increased. Learners can now carry around the computational equivalent of a desktop machine of 5-10 years ago but, of even greater note, are the advancements in *connectivity* – 3G services have facilitated communication of mobile devices to a central server, allowing real-time coordination and interaction between participants. This, combined with the fact that the technology to accurately determine a device's position (especially in an outdoor environment) has become cheaper and therefore increasingly ubiquitous, has created empowered mobile learning platforms that can use a wider awareness of their context as part of the learning experience (Cheverst et al., 2000; Davies, et al., 2001; Ghiani et al., 2009; Rieger & Gay, 1997; Rogers et al., 2004). These efforts have predominantly produced

bespoke applications focussed on individual areas (with notable such as *Mscape* (Hull et al.) for the Windows Mobile operating system). In contrast, the Hyperplace system on which AnswerTree is based is intended as a ubiquitous platform for authoring a range of location-based experiences. This platform is first discussed before AnswerTree is examined in further detail.

HYPERPLACE

Hyperplace is a new client-server based platform for location-based games and services, running as a threaded Java-based server combined with a geospatial database backend in order to store game state and locational information. The server itself stores all of a game's content, presentation logic and rules. This information is transmitted to mobile devices as required through GPRS or (ideally) 3G communications, meaning that clients can be particularly lightweight with the server doing all the heavy lifting and processing (although caching is available on the mobile device when necessary).

This system has been designed to result in a very simple "browser-style" client for the mobile device itself, allowing the front-end to be quickly ported to new mobile platforms[1]. This is aimed specifically at increasing ubiquity and to offer a similar experience to each participant, whichever mobile device that they are using. Once the Hyperplace browser client is installed, any Hyperplace game or service may be used within it without any further installations being required.

Every Hyperplace game consists of three things: a set of game *actions*, a set of game *rules* and a set of *events* that these can generate, with instructions on who needs to know about them. With these three authoring components in place all Hyperplace games then work in a similar fashion – the server sends game updates to player devices, which render these updates (or *statelets*) on the appropriate section of user interface. Players then generate game actions in two ways – either directly via the user interface (such as answering a question or by clicking the map), or indirectly through their behaviour in the physical world (such as moving into a new area). These actions are sent to the server, and administered by the game's particular ruleset. This results in new events being generated that change the state of the game, and when this occurs updates can broadcast to any devices that are impacted by the new state. This circular process is illustrated in detail in Figure 1 below.
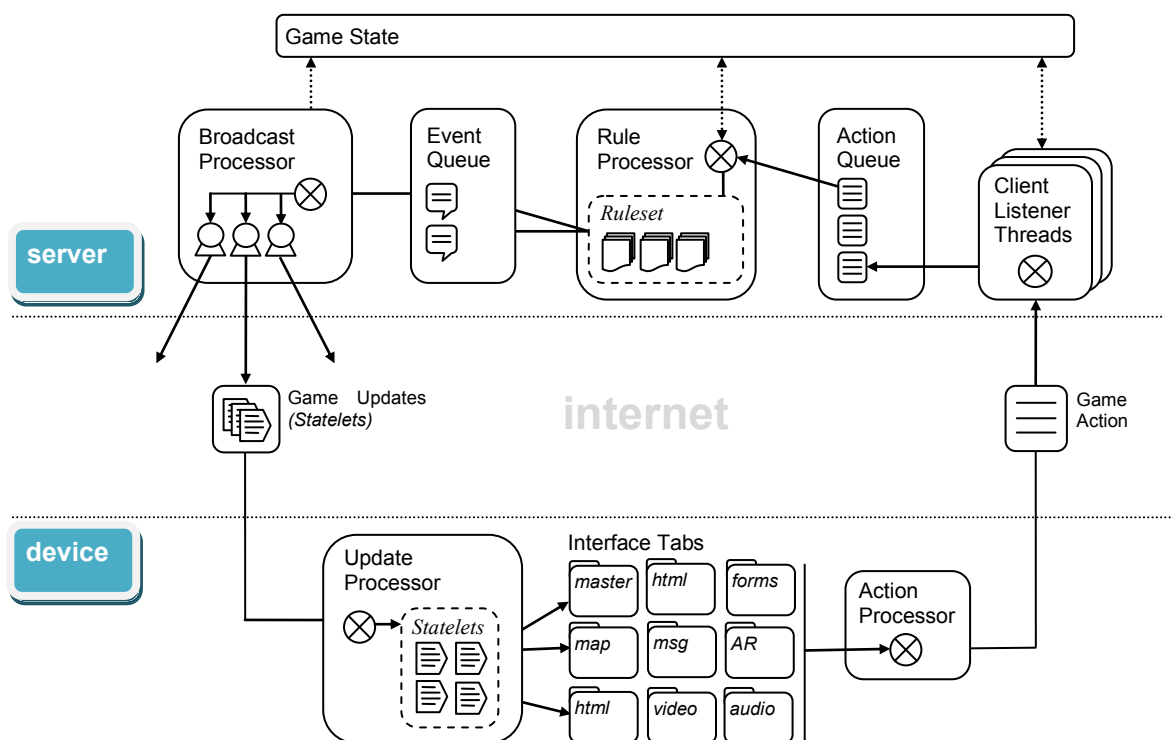

Figure 1. The Hyperplace framework – the interface on the mobile device is composed of a range of tabs. AnswerTree uses 3: Map – a map tab (detailing important locations), Your Info – an html tab for displaying game info (such as the information about the player's current location and their progress in the game), Actions – a game forms tab (with buttons to generate actions such as answering questions, or reading collected cards). A video stub is also currently present in the client but not active. When the player produces an action it is sent to the server, which passes it through the game logic and generates an appropriate response, including any updates to the client interface of affected players.

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[1] Currently clients exist for Google Android and Apple OS. AnswerTree has been played on HTC Magic and G1 phones.

ANSWERTREE

AnswerTree is a specific implementation of the Hyperplace platform. It is based loosely on the idea of a group *Top Trumps™* game. The aim of the game is to collect all the cards in a set about a particular type of object, in this case the trees around University Park at the University of Nottingham. University Park has a rich heritage of arboreal collections, with over 7000 individual specimens and around 200 species present, including some found nowhere else in the UK.

Each learner starts off at the location of one of 5 trees and gains an information card about that tree. They then have to collect the information cards about each of the other trees. Subsequent cards are collected by going to the location of the other trees to collect a question about that tree and then answering that question correctly. The questions are all based on information contained within the card for that tree, so the player must seek out another player that has the card for that tree. The question presented is randomly chosen from a pool that exists for each tree (examples are *"How many different species of wildlife does an oak tree support?"* and *"For about how many weeks per year, does the Cherry Tree flower?"*). Each player's initial tree therefore implicitly becomes the area that they are designated an *expert* on at the start of the game. As the game progresses and more questions are answered and cards collected the number of experts rises until one player has collected all the cards – they are announced as the winner and the game ends. Screenshots from the game are shown in Figure 2.
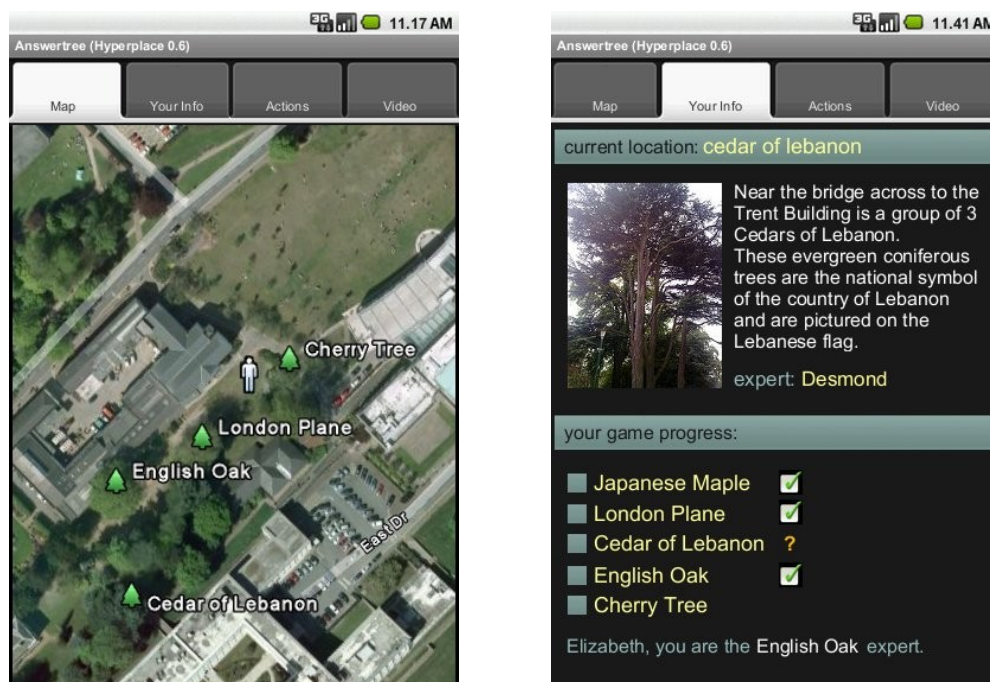

Figure 2. Screenshots of the AnswerTree application running on a Google Android-based mobile phone platform – the *map tab* (the white person icon represents the player) and the *info tab*.

EVALUATION

Since AnswerTree is still in its infancy, a full evaluation has yet to take place. However, initial evaluations carried out by observations and semi-structured interviews with 15 beta testers have provided the following information:

Usability of interface: The tabbed nature of the interface worked well to provide a lot of information in a manageable, usable interface that was well focussed to an individual task. The size of screen was reported as good, with instructions and the map clearly legible and easy to read/follow. Some further development of the on-screen messages was required to enhance clarity. The on-screen keyboard and phone keypad were easy to use and accurate when pressing keys, giving low errors on data entry.

Importance of audio feedback: Testers experienced the game both with and without the integration of audio notifications. Initial observations indicate that audio triggers (such as the when a new tree location is entered, or when an action is successfully completed) are particularly effective in improving orientation within the game. This seems due to the fact that game areas are necessarily fuzzy due to the constraints of GPS accuracy, and because players are often not able to view their display when moving.

Robustness of technical infrastructure: The spatial database communicates seamlessly with the Hyperplace server, which in turn responds almost instantly to client software, allowing location-based data and updates to be synchronised in real time. The average delay between action and response was less than 2 seconds. Maximum delays were noted within the range of 4-5 seconds, occurring when 3G connectivity was momentarily lost. While this is of little concern in environments with a high level of connectivity, it could represent a significant issue in areas of weaker infrastructure. Extension of the system's caching capabilities to handle dropouts or increases in data communication latency must be explored further.

Multi-modal communication: Players were also able interact via phone calls or text messages rather than just through face-to-face means. Although seemingly obvious, the use of mobile phones to allow this facility, when utilised as a gaming platform, is often overlooked. This has proved very successful in allowing the capture and analysis of complex social interactions in another Hyperplace-based game and further work is planned to investigate this within AnswerTree.

Battery life of devices: Hyperplace creates intense computational and sensor loads upon a device, meaning that play time for the games is constrained, usually to under an hour and a half. Larger battery packs can be used to somewhat mitigate this limitation but game design and usability issues need to also be considered.

Limitations of positioning: GPS requires a clear view of the sky on order to provide accurate positions. Tree canopies can obscure this view and so interfere with the game as the players are supposed to be close to the trees in order to interact and claim either the tree itself or a question about the tree. Initially this has been overcome by careful selection of the game space and zoning of the interaction areas. In the future additional technologies, such as near-field tagging, may be used to identify action points for the system.

Further evaluations are planned for early 2010 that will consider educational outcomes from this game, particularly in relation to learning science at Key Stages 2 and 3. We also plan to investigate how AnswerTree could be used to support group learning, in addition to individual learning.

CONCLUSIONS

In this paper we have described AnswerTree, a collaborative location-based educational game designed to promote social interaction and inform KS2/3 students about trees in a fun, game-based manner. The game was run on the Google Android mobile phones, allowing a rich set of complex interactions to be presented and investigated. Initial evaluations surrounding technical and usability issues have indicated the potential for this game to be used with school children to provide environmental education. Further, more extensive trials are planned in the next 6 months, with several groups of target users. The results from these trials will be published in due course.

ACKNOWLEDGMENTS

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